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A Prospective Analysis of Immediate Provisionalization of Single Implants

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Abstract

Purpose: The purpose of this prospective study was to evaluate the viability of immediately provisionalized single-tooth implants.
Materials and Methods: One hundred forty patients (86 female, 54 male) with a mean age at implant placement of 45 years (range, 15–88 years) needing single-tooth replacement, were treated between July 1999 and December 2004. Single-tooth implants were placed and provisionalized the day of the surgery. All implants were manufactured by Nobel Biocare (Yorba Linda, CA) and had multiple diameters and configurations. The majority of the implants used in this study had oxidized titanium surfaces. The contours of the restorations were designed to mimic the original teeth and root forms. The morphology of the restorations provides support of the labial gingiva.
Results: Over 5.5 years, 164 implants were placed and immediately provisionalized. Sixty-four implants were placed immediately post extraction. Seven implants failed, yielding an overall survival rate of 95.73%.
Conclusion: The application of an immediate provisionalization protocol to a single implant can be successful if the proper precautions are taken in achieving passive occlusion.

Excellent long-term results have been achieved with the conventional two-stage implant protocol with delayed loading.[1] Healing periods may be a result of clinical assumptions[2] and appropriate to question as a requisite to osseointegration in all situations. Healing periods for dental implants can impose hardships on patients for many reasons, most obviously inconvenience, discomfort, and embarrassment of removable prostheses. An alternative protocol, known as immediate loading, delivers a prosthesis immediately following implant placement and eliminates many of the aforementioned hardships. Immediate loading features direct occlusal loading and enjoys high success rates.[3] Evidence supports immediate loading if micromotion can be controlled below the threshold that could interfere with osseointegration.[4-6] This technique, however, is susceptible to certain complications, including overload, as exceeding threshold forces of 100 μm can lead to fibrous encapsulation.[7] A third option, known as immediate provisionalization, is becoming a commonplace therapeutic procedure for partially edentulous and dentate patients wishing to replace missing teeth.[8-10] Research illustrates that this technique enjoys high survival rates, varying between 82 and 100%.[11-13] One method of achieving this includes placing sufficient numbers of threaded implants into high-quality bone and connecting them with a rigid restoration.

Immediate loading of multiple implants is significantly different than single, unsplinted implants. Functional loads on a single-tooth implant restoration are applied to the one implant and not spread through a rigid connection to multiple implants. Common clinical practice is for the interim prosthesis placed on the single implant to be fabricated in a manner that eliminates direct occlusal loading.[14,15] After the implant has osseointegrated, the definitive prosthesis can be put into normal function. The purpose of this prospective study was to evaluate the long-term viability of these immediately provisionalized single implants. A secondary purpose of this study was to assess the success rates of varying implant types and surfaces. Past research illustrates that oxidized-titanium-surfaced implants had higher survival rates.[16,17]

Materials and methods

Patients

One hundred forty patients (86 female, 54 male), with a mean age at placement of 45 years (range 15–88 years), needing single-tooth replacement were treated between July 1999 and December 2004 (Fig 1). Inclusion criteria were based on current stable medical condition and ability to undergo dental

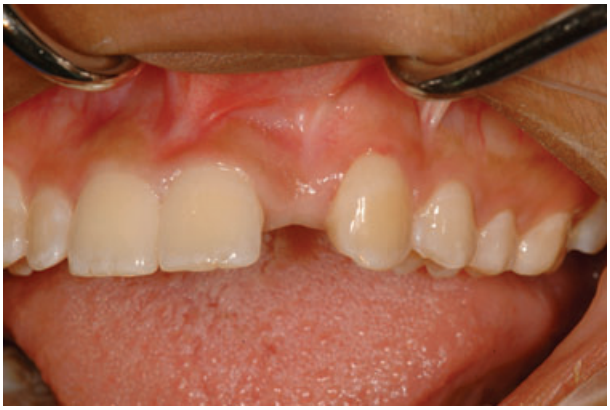

Figure 1 Retracted facial view of missing maxillary left lateral incisor.

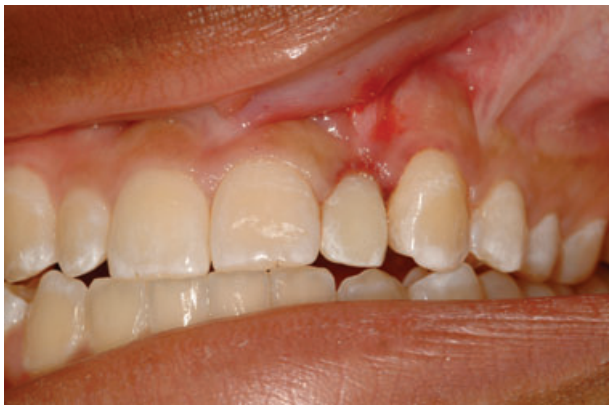

Figure 2 Delivery of Nobel Perfect implant provisional crown for immediate provisionalization.

implant surgery. Exclusion criteria were limited to patients with metabolic bone disease or an unstable systemic condition, such as uncontrolled diabetes, untreated hypothyroidism, or a malignancy in mid-treatment. All patients were treated in a private-practice setting (Prosthodontics Intermedica, Institute for Facial Esthetics, Fort Washington, PA).

Surgical procedure

Local anesthesia was administered as follows: Marcaine 1:200,000 (Cooke-Waite, Abbott Laboratories, North Chicago, IL) and Lignospan 1:100,000 (Septodont, Inc., New Castle, DE). When teeth were present they were carefully removed using thin elevators to dissect the periodontal ligament and allow atraumatic removal of the tooth from the socket while maintaining all available bone surrounding the area. Clinical palpation and lateral cephalometric radiographs assisted in positioning the drills used to create the implant osteotomy site. Profuse saline irrigation is used throughout the drilling procedure. In the esthetic zone, the osteotomy is designed to orient the receptor site toward the palatal aspect of the socket to create an implant angulation similar to that of the natural root but extending far beyond the apex into the premaxillary basal bone. All immediate implants were placed with an insertion torque of at least 45 Ncm using the NobelPharma DEC 100 drill machine (Nobel Biocare, Yorba Linda, CA). Following preparation of the sockets in the esthetic zone, an implant was placed with the shoulder 4 mm below the crest of the gingiva on the labial aspect. A bone guide was often installed and the accompanying trephine was used to remove peripheral bone from the proximal surfaces of the sockets. Typically on external hexed Brånemark implants, a 1-mm CeraOne abutment was installed (NobelBiocare).

Teeth in a Day Prosthetic Procedures

With the abutment in place, a methylmethacrylate custom coping was fitted over the abutment. A prefabricated acrylic resin crown was carefully connected to the plastic coping with a soft mix of acrylic resin. Once the acrylic resin polymerized to the coping, the crown was removed from the abutment, and an abutment analogue was installed in the coping to preserve the integrity of the acrylic resin margins during the refinishing of the acrylic resin restoration. Small amounts of acrylic resin were added to any voids or thin areas that required reinforcement. Once set, the occlusion was adjusted to eliminate contact in all centric and excursive movements, and final contouring/polishing was accomplished.

Clinical treatment continues during this laboratory phase. If required, autogenous bone obtained from the osteotomy site is used to fill voids between the socket wall and the implant surface.

Cementation of the acrylic resin crown is accomplished with carboxylate cement (Duralon, ESPE America Inc., Norristown, PA). Only the thinnest amount of cement was required as to avoid the extrusion of excess into the cervicular area of the fresh extraction site. The contours of this restoration were designed to mimic the original tooth and root form, sealing the socket and maintaining clot formation subgingivally. The morphology of the restoration provides support of the labial gingiva (Fig 2).

No sutures were required when sculpting the restoration in this fashion. This incisionless, sutureless procedure provides an exceptionally fast recovery with very little, if any, postoperative discomfort. Standard protocol for medications following implant surgery was given to patients along with postoperative instructions cautioning premature function on the individual implant.

For many patients, the definitive impression can be made at the time of this one-stage procedure, just prior to cementation of the crown. Cases with gingival swelling due to extensive presurgical periodontal and endodontic pathology are often unsuitable for impression at stage one. Those patients return 4 months after the procedure for the final impression, followed a few days later by delivery of the porcelain-fused-to-gold implant-supported crown. Periapical radiographs were taken on the day of implant placement, definitive prosthesis delivery, and annually. These radiographs had the same angulation through the use of a Rinn Long cone radiographic holder to position the film.

Results

A total of 164 single-tooth implants were placed and provisionalized the day of surgery following the protocol as described

above. The implant sites include the maxillary premolar, canine, lateral, central, and molar, as well as the mandibular premolar, canine, and incisor. There was only one single-tooth implant molar restoration in this study because the clinician authors prefer the use of two implants for a molar;[18] therefore, limited data are present for that area. Sixty-four of the 164 implants were placed in fresh extraction sites, two were immediate replacements for failed implants, and the remaining 98 sites were into healed ridges. At the time of implant placement, the bone quality was determined clinically by the surgeon[19] according to the anatomic and bone density criteria established by Lekholm and Zarb.[20]

The implants were various Nobel Biocare implants with differing diameters and configurations. The majority (151) of the implants used in this study had oxidized titanium surfaces (TiUnite, Nobel Biocare USA); the remaining 13 implants had a machine surface. While 7.7% of machine surface-type implants failed, only 4.0% of TiU surface implants failed. One hundred fifteen implants were regular platform, 39 were wide platform, and 10 were narrow platform (Table 1). Diameters were predominately 4 and 5 mm with implant lengths distributed primarily between 13 and 18 mm. The teeth most often treated in this study were the maxillary lateral incisors (Table 2). Bone quality was primarily type III (59.15%) versus type II (29.88%) and type IV (10.98%) with no type I cases (Table 3). Nine patients were smokers, receiving 12 total implants. Seventy-nine autogenous bone grafts were placed.

Of the 164 implants placed with immediate provisionalization seven implants failed, yielding an overall survival rate of 95.73%. Among the complications noted at failure was soft tissue encapsulation, fracture of buccal bone, infection, a decrease in bone quality, and pain. Of the seven failures, four were in the maxillary premolar area, two in the mandibular incisor region, and one in the mandibular premolar region. Three of the failures were type III bone, three were type IV, and one was type II. Four failures were implants placed into immediate extraction sites (6.25%). Twenty percent of Ebon type implants failed, 3.3% of MK III, and 7.8% of MK IV; there were no failures for MK II, Nobel Perfect, and Brånemark standard type implants (Table 4). Two failures had autogenous bone grafts at the time of placement. Six of the failures had TiUnite surfaces (3.97%); one machined surface implant failed (7.69%). None of the failures were associated with smokers, and one occurred in a diabetic patient, otherwise medical conditions were unremarkable. No occlusal adjustments were necessary, and no provisional crowns became loose.

Table 1 Implant distribution frequency

Quantity	Diameter	Length	Type	Surface	Platform
1	4	15	Ebon	Machine	RP
4	5	13	Ebon	Machine	WP
1	5	10	MK II	Machine	WP
3	4	13	Mk III	TiU	RP
9	4	15	Mk III	TiU	RP
3	4	18	Mk III	TiU	RP
1	5	13	Mk III	TiU	WP
6	3.75	15	Mk III	TiU	RP
8	3.75	18	Mk III	TiU	RP
7	4	10	MK IV	TiU	RP
12	4	13	Mk IV	TiU	RP
21	4	15	Mk IV	TiU	RP
18	4	18	Mk IV	TiU	RP
5	5	13	MK IV	TiU	WP
1	3.75	18	MK IV	TiU	RP
2	3.5	13	Nobel Perfect	TiU	NP
8	3.5	16	Nobel Perfect	TiU	NP
2	4	13	Nobel Perfect	TiU	RP
1	4.3	10	Nobel Perfect	TiU	RP
3	4.3	13	Nobel Perfect	TiU	RP
14	4.3	16	Nobel Perfect	TiU	RP
1	5	10	Nobel Perfect	TiU	WP
4	5	13	Nobel Perfect	TiU	WP
22	5	16	Nobel Perfect	TiU	WP
3	3.75	15	Standard	Machine	RP
1	3.75	18	Standard	Machine	RP
2	4	18	Standard	Machine	RP
1	5	12	Standard	Machine	WP
Total implant population =	164				

Regular platform (RP), narrow platform (NP), wide platform (WP).

Table 2 Implant survival rates by location and implant length

		Length						
Tooth position	Total	10 mm	12 mm	13 mm	15 mm	16 mm	18 mm	Failures
Max premolar	37	6		14	5	12	1	4
Max canine	10				3	2	3	
Max lateral	54			9	15	13	17	
Max central	34			4	10	11	10	
Max molar	1	1						
Mand premolar	18	3	1	9	4	1		1
Mand canine	4				1	1	2	
Mand incisors	6				4	1	1	2
Totals	164	10	1	36	42	41	34	7
Failures	7	2	0	1	4	0	0	
Survival rate	95.73%	80.00%	100.00%	97.22%	90.48%	100.00%	100.00%	

Discussion

Kupeyan and May[4] and Wöhrle[5] reported on a series of 10 and 14 immediately restored implants, respectively, in the maxillary anterior region. Kupeyan and May performed their study in healed ridges with machined titanium implants while Wöhrle reported on roughened implants in immediate extraction sites. All implants in both studies clinically integrated, remaining stable for the observation periods of 6 months to 3 years.

Hui et al[11] did a comparison study of two groups of patients with 24 implants, immediate placement of implants in 11 extraction sites and immediate placement and restoration in 13 extraction sites in the maxillary anterior region. Heavy smokers and patients with a history of bruxism were excluded. Machined-surface implants 13 to 18 mm long were placed with torque values of 40 to 50 Ncm attempting to achieve bicortical anchorage. Interim prostheses were placed out of contact in all excursive movements the day of surgery. No implants were lost, and no complications were encountered.

Glauser et al[12] placed 127 implants (76 maxillary, 51 mandibular) in 41 patients, including smokers. Patients with bruxism and imperfect alveolar ridges were not excluded. Restorations were usually placed the day of surgery and were fabricated in centric occlusal contact without excursive contact. After 1 year, results indicated that 22 implants were lost in 13 patients, including 7 maxillary implants in one patient, for a survival rate of 82.7%. Thirty-four percent of 41 implants in the maxillary posterior area failed, while only 9% of the other 86 implants in all other areas failed. Patients with parafunctional habits (22 implants) had failure more often (41%) than nonbruxers (105 implants, 12%).

Following up on their earlier work, Malo et al[13] coordinated a multicenter study with 116 machined-surface implants with various diameters and configurations placed in 76 patients. Implants were placed in the esthetic zone using underpreparation of the apical aspect of the osteotomies to increase initial stability and increasing insertion torque to greater than 30 Ncm for all implants. Twenty-four patients in this group smoked more than 10 cigarettes per day. The authors reported a 96.5% (112 of 116) success rate for integration and 100% (22 of 22) integration in fresh extraction sockets.

Table 3 Implant survival rates by location and bone quality

		Bone quality					
Tooth position	Total	I	II	III	IV	Fail	% survival
Max premolar	37		3	28	6	4	89.18%
Max canine	10		5	5			100.00%
Max lateral	54		14	30	10		100.00%
Max central	34		15	19			100.00%
Max molar	1			1			100.00%
Mand premolar	18		6	10	2	1	94.44%
Mand canine	4		3	1			100.00%
Mand incisors	6		3	3		2	66.70%
Totals	164	0	49	97	18	7	95.73%
% of cases		0.00%	29.88%	59.15%	10.98%		
Failures	7		1	3	3		
Survival rate		n/a	97.95%	96.91%	83.33%		

Table 4 Implant failure rate by type

Type	Ebon	MK II	MK III	MK IV	NblPrfct	Standard	
Cases	5	1	30	64	57	7	164
% of total cases	3.0%	0.6%	18.3%	39.0%	34.8%	4.3%	
Failures	1		1	5			7
Fail rate	20.0%	0.0%	3.3%	7.8%	0.0%	0.0%	4.3%

These studies show promise for immediate provisionalization of single-tooth implants with a success range from 82% to 100%. In this study, the survival rate was 95.7% during the observation period. Schnitman et al[6] reported on factors affecting the outcome of immediately loaded implants as high primary stability, implant to cortical bone contact percentage, cortical bone density, and control of micromotion during the healing process. Brunski[7] suggests the threshold of forces critical to successful integration is 100 μm, and exceeding this level leads to fibrous encapsulation.

This report shows a trend of higher failure rates in immediate provisionalization of single-tooth implants as the bone quality decreases; however, the sample size of implants placed in Type IV bone is limited, and therefore no definitive conclusion can be made from the bone quality figures. This data does illustrate that successful osseointegration can occur in all bone types with a single-tooth implant immediately provisionalized.

Of the implant designs used in this study, the NobelPerfect implant had the best success rate. All 57 NobelPerfect implants achieved successful osseointegration. The oxidized Ti surface (TiUnite) implants in this study yielded a 96.03% survival rate, a greater percentage than the implants with a machined surface (92.31%). These results support the results from previous reports.[16,17] In regards to implant location, the only implants that failed in the maxillary arch were in the premolar areas. This suggests the possibility of micromotion/overload created by larger forces found in the area of the premolar. In the mandible, there was one failure in the area of the premolars and two failures in the area of the incisors.

The implants in this study were placed consecutively as single teeth and immediately provisionalized. Without the confounding variable of operator judgment, the results should be reproducible by attention to detailed replication of technique and materials.

Conclusion

Immediate provisionalization protocols have proven to be a successful treatment option for the edentulous and partially edentulous patient. Although loading forces are different from an edentulous arch to a partially edentulous or single-tooth restoration, the application of provisionalization to a single implant can be successful if the proper precautions are taken in achieving passive occlusion. The data from this study supports this treatment option by reporting a 95.73% survival rate for a population of 164 immediately provisionalized single-tooth implants.

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